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REPLY

Concerns on Sleep Assessment Complexity and Nasal Resistance Effects in Empty Nose Syndrome

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To the Editor,

We sincerely thank the authors for their interest in our recent publication [1] and for their thoughtful comments regarding the complexity of sleep assessment in patients with empty nose syndrome (ENS). We are grateful for the opportunity to clarify several aspects of our study and to address the points raised.

1 | On the Assertion that the Study "Relied Solely on Subjective Sleep Metrics"

We respectfully clarify that our study did incorporate objective sleep measures, most notably full-night polysomnography (PSG), performed preoperatively and at 6 months postoperatively for all enrolled participants (see *Methods* 2.3 and *Results* 3.3). As detailed

TABLE 1 | Comparison of prereconstruction and postreconstruction PSG parameters in ENS patients [1].

Variable ($n = 39$)	Prereconstruction	Postreconstruction	p value
BMI (kg/m^2)	25.0 ± 3.3	25.2 ± 3.4	0.188
AHI (events/h)	23.1 ± 22.8	27.2 ± 25.1	0.267
AI (events/h)	9.7 ± 20.9	11.1 ± 19.3	0.988
HI (events/h)	13.4 ± 11.6	16.1 ± 11.7	0.185
Arousal index (events/h)	24.3 ± 15.7	26.1 ± 14.6	0.292
Snore index (events/h)	261.6 ± 168.6	252.1 ± 169.5	0.667
Mean SpO_2 (%)	95.5 ± 2.8	93.0 ± 14.0	0.164
Lowest SpO_2 (%)	85.5 ± 11.5	85.1 ± 9.8	0.592

All values are reported as mean ± SD for continuous variables.

Abbreviations: AI, apnea index; AHI, apnea-hypopnea index; BMI, body mass index; ENS, empty nose syndrome; HI, hypopnea index; PSG, polysomnography; SpO_2, oxygen saturation.

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in Table 1, a comprehensive set of PSG parameters, including apnea–hypopnea index, arousal index, snore index, and sleep stage architecture, were systematically analyzed.

While subjective assessments, such as the Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (EpSS), showed significant postreconstruction improvement, PSG parameters did not reach statistical significance. Similarly, no significant changes in sleep architecture were observed following surgery. It is important to note that prior research has demonstrated that the PSQI and EpSS assess orthogonal and independent dimensions of sleep health, and neither has consistently correlated with objective PSG indices [2, 3]. These observations support that each measurement tool captures a distinct and complementary aspect of sleep-related well-being. We have addressed this discrepancy in the *Discussion* section and interpreted it as a meaningful finding, potentially reflecting the perceptual and affective modulation observed in ENS.

In contrast to patients with obstructive sleep apnea due primarily to increased airway resistance, sleep disturbance in ENS is part of a more complex entity. Core manifestations, including ENS-specific symptoms, psychiatric status, and sleep disturbances, are highly interrelated. As shown in Table 2, postreconstruction improvements in both the EpSS and the PSQI reaching the minimal clinically important difference (MCID) were associated with psychiatric status. Furthermore, changes in the snore index measured by PSG were related to the presence or absence of postreconstruction anxious symptomatology (Figure 1). While ENS patients demonstrated notable improvements in nocturnal sleep quality and daytime sleepiness following reconstruction, such improvements may not be fully captured by PSG metrics alone.

Given the multifaceted nature of ENS, we strongly support the authors' suggestion to adopt a multimodal sleep assessment strategy in future studies. Such an approach may help elucidate the mechanisms underlying sleep alterations in ENS and ultimately enhance surgical outcomes.

2 | On the Issue of Causal Inference Between Nasal Resistance and Sleep Improvement

We appreciate the concern regarding the attribution of improved sleep quality to changes in nasal resistance. We would like to clarify that our manuscript does not claim a causal relationship between nasal resistance and sleep outcomes. We made no claims that changes in nasal resistance influenced either subjective sleep assessments or PSG-based parameters.

Previous literature suggests that postoperative improvements in ENS symptoms are more closely associated with the restoration of nasal airflow to the inferior meatus, rather than with recovery in nasal resistance per se [4]. Accordingly, nasal resistance measurements obtained via anterior rhinomanometry may not adequately reflect the full symptom burden experienced by patients with ENS [5]. To more accurately elucidate the relationship between sleep improvements and postreconstruction changes in nasal airflow dynamics, further investigations, particularly those employing computational fluid dynamics modeling, may be warranted.

TABLE 2 | Association between postreconstruction depressive traits, anxious traits, and achieving MCID in PSQI and EpSS scores for ENS patients [1].

	PSQI							EpSS						
	Achieving MCID		Not achieving MCID		χ^2 (df)	*p* value	*Phi*	Achieving MCID		Not achieving MCID		χ^2 (df)	*p* value	*Phi*
	n	%	*n*	%				*n*	%	*n*	%			
PostOP depressive symptomatology					7.071	0.011*	−0.443					4.179	0.087	−0.327
No	13	92.9	11	50.0				15	83.3	11	52.4			
Yes	1	7.1	11	50.0				3	16.7	10	47.6			
PostOP anxious symptomatology					3.736	0.53	−0.327					3.291	0.103	−0.298
No	10	71.4	8	38.1				12	66.7	7	36.8			
Yes	4	28.6	13	61.9				6	33.3	12	63.2			

The analysis was conducted using a chi-square test.
Abbreviations: ENS, empty nose syndrome; EpSS, Epworth Sleepiness Scale; MCID, minimally clinically important difference; PSQI, Pittsburgh Sleep Quality Index; PostOP, postreconstruction.
*$p < 0.05$.

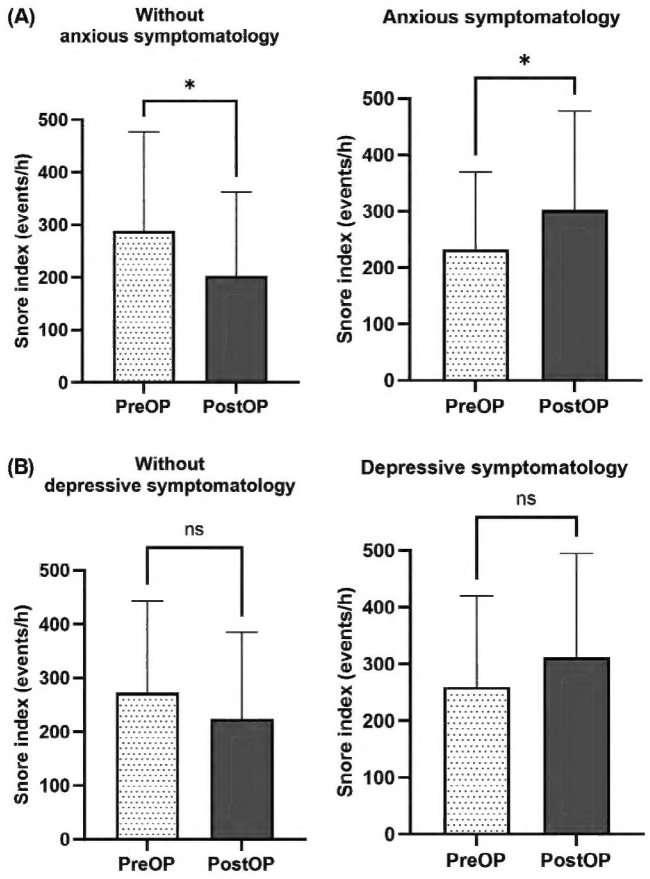

FIGURE 1 | Analysis of the impact of post-reconstruction psychiatric status on changes in snore index [1]. (A) Pre- and post-reconstruction snore index changes in patients without and with post-reconstruction anxious symptomatology. (B) Pre- and post-reconstruction snore index changes in patients witout and with post-reconstruction depressive symptomatology. PreOP, pre-reconstruction; PostOP, post-reconstruction; ns, non-significance. *$p < 0.05$. [1]

3 | Conclusion

We thank the authors again for their thoughtful engagement and critical perspective, which contribute meaningfully to the ongoing discourse in ENS research. We hope this response clarifies the methodological considerations and the subtle aspects of interpreting our findings.

References

1. H. A. Hsueh, T. J. Lee, L. P. Chuang, et al., "Postoperative Sleep Outcomes in Empty Nose Syndrome: Associations With Psychiatric Symptomatology," *International Forum of Allergy & Rhinology*, accessed May 30, 2025, https://doi.org/10.1002/alr.23615.

2. D. J. Buysse, M. L. Hall, P. J. Strollo, et al., "Relationships Between the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and Clinical/Polysomnographic Measures in a Community Sample," *Journal of Clinical Sleep Medicine* 4, no. 6 (2008): 563–571.

3. P. Mondal, J. A. Gjevre, R. M. Taylor-Gjevre, and H. J. Lim, "Relationship Between the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale in a Sleep Laboratory Referral Population," *Nature and Science of Sleep* 5 (2013): 15–21.

4. J. Malik, S. Dholakia, B. M. Spector, et al., "Inferior Meatus Augmentation Procedure (IMAP) Normalizes Nasal Airflow Patterns in Empty Nose Syndrome Patients via Computational Fluid Dynamics (CFD) Modeling," *International Forum of Allergy & Rhinology* 11, no. 5 (2021): 902–909.

5. C. H. Fu, C. C. Chen, C. C. Huang, et al., "Morphology, Not Only Volume: A Study on Empty Nose Syndrome and Inferior Turbinates," *Laryngoscope* 134, no. 7 (2024): 3060–3066.